CLAIMS

What is claimed is:

1. A process for cultivating photosynthetic microbes, comprising:

selecting a species of photosynthetic microbe capable of doubling in biomass in approximately 16 hours or less when supplied with sufficient carbon dioxide in an open system that has a carrying capacity;

introducing said species into a closed system;

allowing said species to grow in said closed system to a biomass that exceeds 5% of said open system's carrying capacity;

inoculating an initial biomass of said species that is no less than 5% of said carrying capacity from said closed system into said open system;

supplying carbon dioxide to said open system continuously, to supply sufficient carbon dioxide to said microbes and to replace carbon dioxide removed by said microbes; and

maintaining said species in said open system to double in biomass approximately every 16 hours or less for a period of less than 5 days.

2. A process according to claim 1, wherein said photosynthetic microbe is selected from the group consisting of bacteria, cyanobacteria and algae.

3. A process according to claim 1, wherein said species doubles in biomass in said open system at a rate between approximately 1.5 doublings per day and up to approximately 8 doublings per day.

4. A process according to claim 1, wherein said species doubles in biomass in said open system at a rate between at least once every 16 hours and up to once every 3 hours.

5. A process according to claim 4, further comprising removing substantially all of said species from said open system at most 5 days after said inoculating step.

6. A process according to claim 1, wherein said maintaining step is performed so that growth of said species is limited by availability of carbon dioxide.

7. A process according to claim 1, wherein said maintaining step is performed until after said species has reaches approximately 90% of said carrying capacity.

8. A process according to claim 1, wherein said supplying step is performed using stack gas from a source selected from the group consisting of the burning of a fossil fuel, the industrial production of chemicals, or the extraction of fossil fuels from geological deposits of fossil fuels.

9. A process for synthesizing oil, comprising:

selecting a species of photosynthetic microbe that doubles in biomass in approximately 16 hours or less when supplied with sufficient carbon dioxide in an open system that has a carrying capacity;

introducing said species into a closed system;

culturing said species in said closed system until said species grows to a biomass that exceeds 5% of said open system's carrying capacity;

inoculating an initial biomass of said species that is no less than 5% of said carrying capacity from said closed system into said open system;

supplying carbon dioxide to said open system continuously, to supply sufficient carbon dioxide to said microbes and to replace carbon dioxide removed by said microbes; and

maintaining said species in said open system to double approximately every 16 hours or less for a period of less than

5 days until said species attains approximately 90% of said carrying capacity.

10. A process for culturing photosynthetic microbes, comprising:

selecting a photosynthetic microbe that has a growth rate of at least approximately one doubling every 16 hours when supplied with sufficient carbon dioxide in an open system having a carrying capacity;

culturing said microbe in a closed system;

inoculating an open system with an amount of said microbes from said closed system equal to approximately 5% or more of said carrying capacity;

supplying carbon dioxide to said open system continuously, to supply sufficient carbon dioxide to said microbes and to replace carbon dioxide removed by said microbes;

maintaining said microbes in said open system to grow at at least said growth rate; and

harvesting said microbes from said open system less than approximately 5 days after said inoculating step.

11. A process according to claim 10, further comprising:

maintaining said open system so growth of said microbes is limited by availability of carbon dioxide.

12. A process for creating biomass feedstock, comprising:

selecting a species of photosynthetic microbe that doubles in biomass in approximately 16 hours or less when supplied with sufficient carbon dioxide in an open system that has a carrying capacity;

introducing said species into a closed system until said species grows to a biomass that exceeds 5% of said carrying capacity;

inoculating an initial biomass of said species that is no less than 5% of said carrying capacity from said closed system into said open system;

supplying carbon dioxide to said open system continuously, to supply sufficient carbon dioxide to said species and to replace carbon dioxide removed by said species; and

maintaining said species in said open system to double approximately every 16 hours or less for a period of less than 5 days to create a biomass feedstock.

13. A process for using stack gas, comprising:

selecting a species of photosynthetic microbe that doubles in biomass in approximately 16 hours or less when supplied with sufficient carbon dioxide in an open system that has a carrying capacity;

introducing said species into a closed system;

supplying said stack gas into said closed system;

allowing said species to grow in said closed system and to use said stack gas to grow to a biomass that exceeds 5% of said open system's carrying capacity;

inoculating an initial biomass of said species that is no less than 5% of said carrying capacity from said closed system into said open system;

supplying said stack gas to said open system continuously, to supply sufficient carbon dioxide to said species and to replace carbon dioxide removed by said species; and

maintaining said species in said open system to double in biomass approximately every 16 hours or less for a period of less than 5 days.

14. A process for synthesizing oil, comprising:

selecting photosynthetic microbes that double in biomass in approximately 16 hours or less when supplied with

sufficient carbon dioxide in an open pond having a carrying capacity;

injecting stack gases having carbon dioxide concentrations of at least 3.5% into a photobioreactor having a maximum culture depth of approximately 20 centimeters, wherein said stack gases are selected from the source consisting of burning a fossil fuel, industrial production of chemicals, refining of oil and gas, and geological extraction of fossil fuels;

introducing said microbes into said photobioreactor;

providing said microbes with sufficient nutrients in said photobioreactor to avoid nutrients being a limiting factor to growth;

turbulent mixing of said microbes throughout said photobioreactor, whereby said microbes undergo continuous exponential growth in said photobioreactor;

inoculating an initial biomass of said microbes that is no less than 5% of said carrying capacity of said open pond from said closed photobioreactor into said open pond;

supplying carbon dioxide to said open system continuously, to supply sufficient carbon dioxide to said microbes an to replace carbon dioxide removed by said microbes; and

maintaining said microbes in said open pond with high nutrient concentrations for at most 5 days, whereby initial conditions of high light intensity and high nutrient concentrations favor continued exponential growth for a short period, but wherein growth becomes limited by nitrogen availability which inhibits protein synthesis, whereby oil content is increased.

15. A process for biosynthesis of oil, comprising:

selecting photosynthetic microbes that double in biomass in approximately 16 hours or less when supplied with

sufficient carbon dioxide in an open pond having a carrying capacity;

dissolving stack gases having carbon dioxide concentrations of at least 3.5% in a culture medium in a photobioreactor having a maximum culture depth of approximately 20 centimeters, wherein said stack gases are selected from a source selected from the group consisting of burning a fossil fuel, industrial production of chemicals, refining of fossil fuels, and geological extraction of fossil fuels;

introducing said microbes into said medium in said photobioreactor;

providing said microbes with sufficient nutrients in said medium to avoid nutrients being a limiting factor to growth;

turbulent mixing of said microbes in said medium throughout said photobioreactor to provide a substantially homogeneous distribution of said microbes in said medium, whereby said microbes undergo continuous exponential growth in said photobioreactor;

inoculating an initial biomass of said microbes that is no less than 5% of said carrying capacity of said open pond from said closed photobioreactor into said open pond;

supplying stack gases having carbon dioxide concentrations of at least 3.5% to said open pond continuously, to supply sufficient carbon dioxide to said microbes and to replace carbon dioxide removed by said microbes, wherein said stack gases are selected from a source selected from the group consisting of burning a fossil fuel, industrial production of chemicals, refining of fossil fuels, and geological extraction of fossil fuels; and

maintaining said microbes in said open pond with high nutrient concentrations for at most 5 days, whereby initial conditions of high light intensity and high nutrient concentrations favor continued exponential growth for a short

period, but wherein growth becomes limited by nitrogen availability which inhibits protein synthesis, whereby oil content is increased.

16. A process for synthesizing biomass on a land area, comprising:

selecting photosynthetic microbes that double in biomass in approximately 4 hours or less when supplied with sufficient carbon dioxide in an open pond having a carrying capacity;

introducing said microbes into a photobioreactor having a maximum culture depth of approximately 20 centimeters, wherein said photobioreactor occupies less than 20% of said land area;

providing said microbes with sufficient nutrients in said photobioreactor to avoid nutrients being a limiting factor to growth;

turbulent mixing of said microbes throughout said photobioreactor, whereby said microbes undergo continuous exponential growth in said photobioreactor;

inoculating an initial biomass of said microbes that is no less than 15% of said carrying capacity from said photobioreactor into said open pond, wherein said open pond occupies more than 80% of said land area;

supplying carbon dioxide to said open pond continuously, to supply sufficient carbon dioxide to said microbes an to replace carbon dioxide removed by said microbes; and

maintaining said microbes in said open pond with high nutrient concentrations for at most 1 day, whereby initial conditions of high light intensity and high nutrient concentrations favor continued exponential growth for a short period, but wherein growth becomes limited by light due to proliferation of cells.

17. A process for biosynthesis of oil, comprising:

selecting photosynthetic microbes that double in biomass in approximately 16 hours or less when supplied with

sufficient carbon dioxide in an open pond having a carrying capacity;

dissolving stack gases having carbon dioxide concentrations of at least 3.5% in a culture medium in a photobioreactor having a maximum culture depth of approximately 20 centimeters, wherein said stack gases are selected from a source selected from the group consisting of burning a fossil fuel, industrial production of chemicals, refining of fossil fuels, and geological extraction of fossil fuels;

introducing said microbes into said medium in said photobioreactor;

providing said microbes with sufficient nutrients in said medium to avoid nutrients being a limiting factor to growth;

turbulent mixing of said microbes in said medium throughout said photobioreactor, whereby said microbes undergo continuous exponential growth in said photobioreactor;

inoculating an initial biomass of said microbes that is no less than 5% of said carrying capacity of said open pond from said closed photobioreactor into said open pond;

supplying carbon dioxide to said open pond continuously, to supply sufficient carbon dioxide to said microbes an to replace carbon dioxide removed by said microbes; and

maintaining said microbes in said open pond with high nutrient concentrations for at most 5 days, whereby initial conditions of high light intensity and high nutrient concentrations favor continued exponential growth for a short period, but wherein growth becomes limited by nitrogen availability which inhibits protein synthesis, whereby oil content is increased.

18. A process for synthesizing biomass feedstock, comprising:

selecting photosynthetic microbes that double in biomass in approximately 4 hours or less when supplied with sufficient carbon dioxide in an open pond having a carrying capacity;

dissolving stack gases having carbon dioxide concentrations of at least 3.5% in a culture medium in a photobioreactor having a maximum culture depth of approximately 20 centimeters, wherein said stack gases are selected from a source selected from the group consisting of burning a fossil fuel, industrial production of chemicals, refining of fossil fuels, and geological extraction of fossil fuels;

introducing said microbes into said medium in said photobioreactor;

providing said microbes with sufficient nutrients in said medium to avoid nutrients being a limiting factor to growth;

turbulent mixing of said microbes in said medium throughout said photobioreactor, whereby said microbes undergo continuous exponential growth in said photobioreactor;

inoculating an initial biomass of said microbes that is no less than 15% of said carrying capacity of said open pond from said closed photobioreactor into said open pond;

supplying carbon dioxide to said open pond continuously, to supply sufficient carbon dioxide to said microbes an to replace carbon dioxide removed by said microbes; and

maintaining said microbes in said open pond with high nutrient concentrations for at most 1 day, whereby initial conditions of high light intensity and high nutrient concentrations favor continued exponential growth for a short period, but wherein growth becomes limited by light due to proliferation of cells.

19. A device for cultivating photosynthetic microbes on a land area, comprising:

one or more culture vessels transparent to visible light, each culture vessel providing a culture depth of at most 40

centimeters, wherein said culture vessels cover a plan area of said land area and portions of said land area between said culture vessels define an inert area;

a nutrient medium in each of said culture vessels;

turbulent flow means for creating turbulent flow throughout said nutrient medium in each of said culture vessels, wherein said turbulent flow is sufficiently low to prevent mechanical shear from damaging cells, said culture vessels, said nutrient medium and said turbulent flow means defining one or more photobioreactors;

wherein said plan area and said inert area occupy no more than 20% of said land area; and

one or more open ponds, each having a carrying capacity, which together occupy no less than 80% of said land area;

whereby a biomass of microbes comprising at least 5% of said carrying capacity for each of said open ponds can be inoculated from said photobioreactors into said open ponds.